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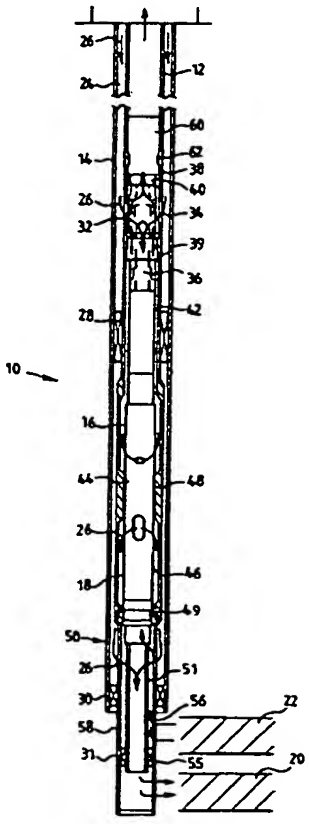
(54) Abstract Title
Improvements in downhole pumps

(57) A method of improving production from a producing zone (22) in a hydrocarbon-producing well comprises the steps of pumping injection water into the well, utilising the injection water to drive a downhole pump (18), and utilising the pump (18) to increase the pressure of production fluid flowing from the producing zone to the surface.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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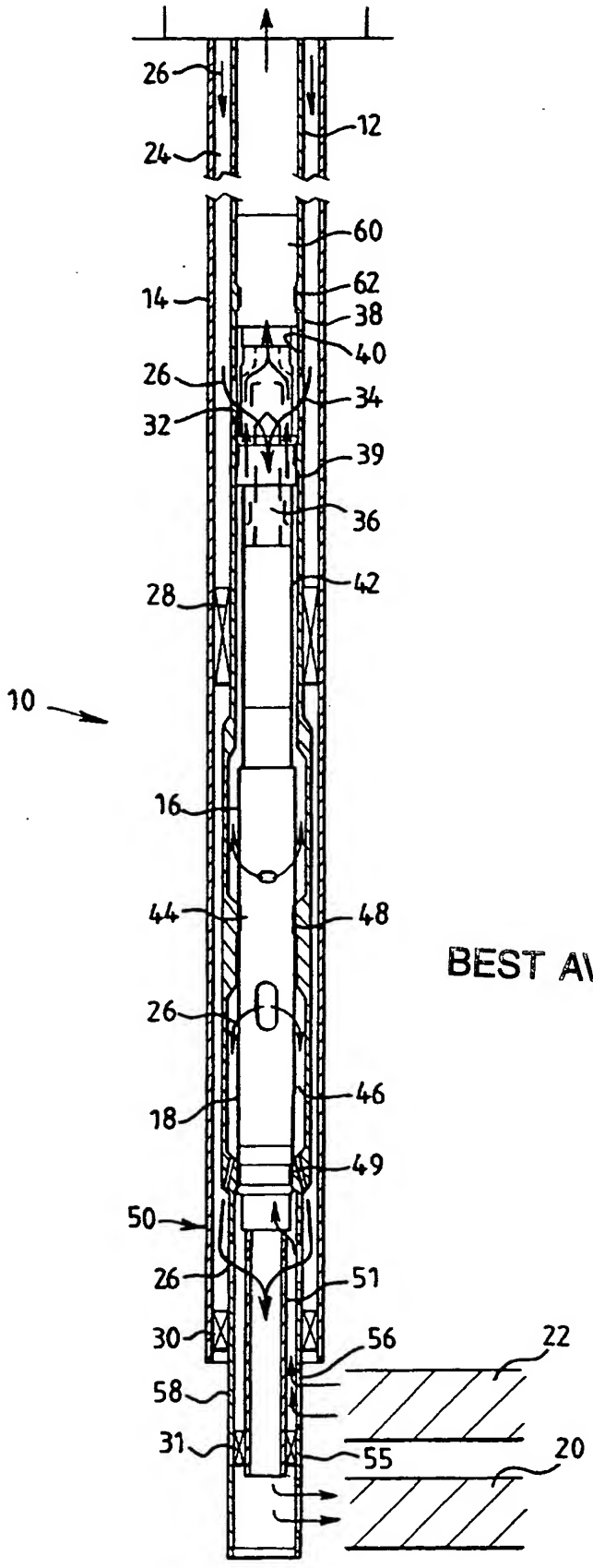

IMPROVEMENTS IN DOWNHOLE PUMPS

This invention relates to improvements in downhole pumps, and in particular to a downhole pump suitable for use in oil and gas exploration and production.

In any oilfield, fluid extracted from a hydrocarbon reservoir in a hydrocarbon-bearing formation is a mixture of fluids including hydrocarbon liquids and perhaps also hydrocarbon gas and water, with any gas or water present being separated from the hydrocarbon liquids at the surface. The gas may be collected or flared off, while the "produced" water may be dumped, after cleaning, or used for injection purposes, as will be described below.

In some applications, the performance of a hydrocarbon-producing well is enhanced by means of a pressure boost, which may be achieved by a downhole pump for assisting the flow of fluid to the surface. It is also common practice to maintain the pressure in a producing reservoir by injection of produced water or sea-water, the water being injected through wells which are separate from those which are used to produce hydrocarbons, but with both producing and injection wells connected to the same formation.

It is among the objectives of aspects of the present invention to provide a pump and a method for permitting production and injection in a single hydrocarbon-producing well.

According to the present invention there is provided

a method of improving production from a producing zone in a hydrocarbon-producing well, the method comprising the steps of:

pumping injection water into a hydrocarbon-producing well;

utilising the injection water to drive a downhole pump; and

utilising the pump to increase the pressure of production fluid flowing from the producing zone to the surface.

Some formation structures are such that the possibility exists for production and injection in a single well, and the present invention allows the advantages of this formation feature to be utilised, with the result that wells previously considered to be uneconomic for production may be exploited.

Preferably, the pump comprises a drive section and a pump section having driver and pump fluid discharges arranged in a cross-flow arrangement to prevent co-mingling of the fluids in the well bore.

The drive section of the downhole pump may include a turbine or a positive displacement motor.

The downhole pump may be located in a section of production tubing, above or adjacent the production zone. The injection water may be delivered to the pump via the annulus defined between the production tubing and the well bore casing. The production tubing may define appropriate ports to permit the injection water to flow into and then

discharge from the pump drive section, and one or more packers may be provided in the annulus to assist in directing the flow of water.

The pump may form part of the production string, or may be installed by wireline or some other appropriate support, engaging appropriate nipple profiles in the production tubing.

This and other aspects of the present invention will now be described, by way of example, with reference to the accompany drawing, which is a schematic sectional view of a pump assembly for use in a method in accordance with a preferred embodiment of the present invention.

The pump assembly 10 is shown in a section of production tubing 12 itself located within a section of well casing 14. The pump assembly 10 utilises injection water, in the form of produced water pressurised at the surface, to power a fluid turbine 16 driving a downhole pump 18. The pump 18 boosts the pressure of production fluids from the producing zone 22 to the surface. After discharging from the turbine 16 the water is injected into an underground formation injection zone 20.

The injection water 26 is pumped from the surface through the annulus 24 between the production tubing 12 and the well casing 14. In the vicinity of the pump assembly 10 the flow of injection water is diverted by a first packer 28 located in the annulus 24. Above the packer 28, the production tubing 12 defines a port 32 through which the produced water passes to flow through a flow crossover

34 into a central pump tube 36. The crossover 34 is located between a pair of seals 38, 39 which engage a seal bore 40 provided in the tubing 12. The crossover 34 also includes a junk basket assembly 42. From the central tube 36, the injection water passes through the turbine 16.

After passing through the turbine 16, the injection water passes through a second flow crossover 44 in the downhole pump assembly 18 and is returned to the annulus 24, below the packer 28. As with the first crossover 34, the second crossover 44 occurs at a seal bore 46 between a pair of seals 48, 49.

The production zone 22 is isolated from the injection water by a pair of production packers 30 and 31 and above the production zone 22 the injection water passes through a third flow crossover 50 into a centrally located section of tubing 51 within a lower portion of the production tubing 12. The injection water then passes downwardly to the injection zone 20.

The production fluid flows from the production zone 22 through a gap 56 between the lower end of the production tubing 12 and the upper end of tubing 55 installed with the packer 31 relative to the tubing 51, into an annular tubing section 58 which carries the production fluid through the flow crossover 50. The production fluid is then drawn into the downhole pump 18, which will be typically of the multistage centrifugal type, before passing through the pump assembly flow crossover 44 and being discharged from the pump assembly above the seal 48. The fluid then flows

upwardly, externally of the tube 36, through the first flow crossover 34 and into the production tubing 12, from where the fluid flows to the surface.

The illustrated apparatus 10 is installed using a wireline, and is therefore provided with a lock mandrel 60 for engaging an appropriate nipple profile 62 formed in the production tubing 12.

In use, the apparatus 10 allows boosting of production in a well through use of a downhole pump utilising injection water as the power or driver fluid for the pump. As the injection water and the production fluid do not co-mingle, there is no requirement to separate the water and fluid at the surface. Further, produced water separated from the production fluid may be utilised for injection, and thus does not require cleaning that would otherwise be required if the produced water was to be dumped.

It will be clear to those of skill in the art that the above-described embodiment is merely exemplary of the present invention, and that various modifications and improvements may be made thereto, without departing from the scope of the invention.

CLAIMS

1. A method of improving production from a producing zone in a hydrocarbon-producing well, the method comprising the steps of:

pumping injection water into a hydrocarbon-producing well;

utilising the injection water to drive a downhole pump; and

utilising the pump to increase the pressure of production fluid flowing from a producing zone of the well to the surface.

2. The method of claim 1, further comprising providing a downhole pump comprising a drive section and a pump section having driver and pump fluid discharges arranged in a cross-flow arrangement to prevent co-mingling of the fluids in the well bore.

3. The method of claim 2, further comprising providing a pump having a drive section including a turbine.

4. The method of claim 2, further comprising providing a pump having a drive section including a positive displacement motor.

5. The method of any of the preceding claims, further

comprising locating the downhole pump in a section of production tubing.

6. The method of claim 5, further comprising delivering the injection water to the pump via the annulus defined between the production tubing and the well bore casing.

7. The method of claim 6, further comprising providing the production tubing with ports to permit the injection water to flow into and then discharge from the pump drive section.

8. The method of claim 6 or 7, further comprising providing one or more packers in the annulus to assist in directing the flow of water.

9. The method of any of claims 5 to 8, further comprising providing the pump as a part of the production string.

10. The method of any of claims 5 to 8, further comprising providing the pump separately of the production string and locating the pump in a nipple profile in the production tubing.

11. The method of improving production from a producing zone in a hydrocarbon-producing well substantially as described herein and as illustrated in the accompanying drawing.

The Patent Office

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Application No: GB 9804015.7 **Examiner:** Robert Fender
Claims searched: 1-11 **Date of search:** 4 August 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): E1F: FMU

Int Cl (Ed.6): E21B 43/18, 43/20

Other: -

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2053324 A (KOBE INC.)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.